GROUND-LIVING SPIDERS (ARANEAE) ONE YEAR AFTER FIRE IN THREE SUBARCTIC FOREST TYPES, QUÉBEC (CANADA)

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Koponen, S. 1993 11 11: Ground-living spiders (Araneae) one year after fire in three subarctic forest types, Québec (Canada). *Memoirs of the Queensland Museum* 33(2): 575-578. Brisbane. ISSN 0079-8835.

The ground-living spider fauna was studied one year after fire using pitfall traps in three forest types of subarctic Québec, July-August 1990. About 30 species, of the total 47 found at burned sites, were regarded as pioneer or colonizer species. Spiders captured commonly at burned sites included e.g. *Gnaphosa microps* Holm, *G. muscorum* (L. Koch), *Pardosa hyperborea* (Thorell), *P. uintana* Gertsch, *Trochosa terricola* Thorell, *Alopecosa aculeata* (Clerck), *Diplocentria bidentata* (Emerton), and *Sisis rotundus* (Emerton). Some species were found only or predominantly at unburned sites; e.g. *Pardosa moesta* Banks and *Lepthyphantes complicatus* (Emerton).

En juillet-août 1990, une année après des incendies, la faune des araignées habitant sur le sol des trois types de fôret du Québec subarctique a été étudiée en utilisant des pièges-fosses. Environ 30 espèces, d'un total de 47 trouvées dans les sites brûlés, ont été considerées comme des espèces pionnières ou colonisatrices. Les araignées capturées généralement dans les sites brûlés comprennent par exemple *Gnaphosa microps* Holm, *G. muscorum* (L. Koch), *Pardosa hyperborea* (Thorell), *P. uintana* Gertsch, *Trochosa terricola* Thorell, *Alopecosa aculeata* (Clerck), *Diplocentria bidentata* (Emerton), et *Sisis rotundatus* (Emerton). Quelques espèces ont été trouvées seulement ou principalement dans les sites non brûlés, par exemple, *Pardosa moesta* Banks et *Lepthyphantes complicatus* (Emerton). □*Araneae, forest fire, subarctic, Canada.*

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Fire history, effect of fire on forest vegetation, and postfire succession of plant cover have been studied in detail in northern Québec (e.g. Payette *et al.*, 1989). By contrast, very little is known about the effects of fire on spiders in northern forests of North America. In central Alaska, Beckwith and Werner (1979) suggested that the decrease of many arthropod populations after fire can be attributed to increasing spider populations and predation by spiders. Data from temperate forests of North America are also markedly scant (e.g. Pearse, 1943; Buffington, 1967). Pearse (1943) listed about 35 species of spiders from burned pine forests in North Carolina; however, individual numbers were low.

In forests of northern Europe, postfire spider faunas and their succession have been studied both after natural fires and prescribed burning (e.g. Huhta, 1971; Schaefer, 1980; Hauge and Kvamme, 1983; Koponen, 1988, 1989). Data from subarctic forests of Europe are available only from northern Finland (Huhta, 1971; Koponen, 1988, 1989).

This paper deals with the effects of fire on ground-living spiders at the beginning of faunal succession in three forest types in the subarctic zone of Québec, Canada. Forest fires occurred in midsummer 1989; samples were collected in 1990 during the first postfire summer.

MATERIALS AND METHODS

The study areas were situated 1) at Lac Ekomiak (53°23'N, 77°30'W), south of La Grande/Radisson and 2) at Kuujjuarapik (Poste-de-la-Baleine; 55°17'N, 77°48'W) on the eastern coast of Hudson Bay (Fig. 1). Both study areas were near the northern limits of the boreal forest.

1. At Lac Ekomiak, large areas of forest (thousands of sq. km) were burned in midsummer 1989. The study sites situated near the border of this extensive fire area were in dry and mesic forest. The main tree species were *Pinus banksiana* Lamb. and *Picea mariana* (Mill.) B.S.B. at dry sites; *Picea mariana* and *Larix laricina* (Du Roi) K. Koch at mesic sites. The ground layer of the dry sites was characterized by *Cladonia* and *Pleurozium*; that of the mesic sites by *Sphagnum* and *Pleurozium*. The fire had been very intensive and had killed all trees and destroyed field and ground layer vegetation totally. The trapping

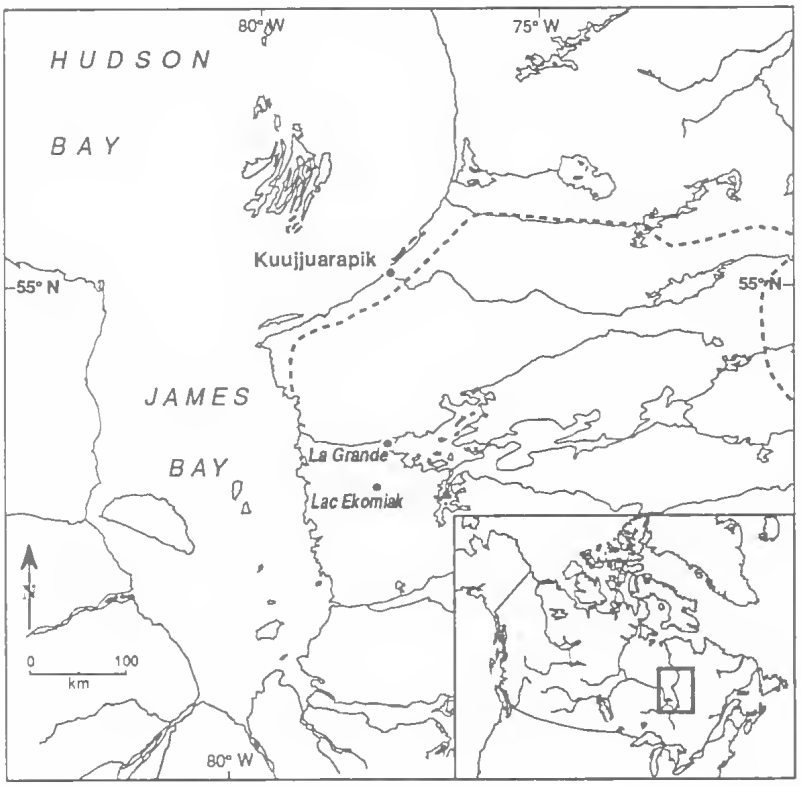

FIG. 1 (left). Postfire study sites at Lac Ekomiak and Kuujjuarapik, Québec. Broken line indicates the northern limit of the continuous (subarctic) forest.

TABLE 1 (right). Total number of individuals in major spider families, total number of species, diversity (H) and evenness (E) for pitfall trap material at Lac Ekomiak and Kuujjuarapik, Québec. LDB = Lac Ekomiak dry burned, LDC = Lac Ekomiak dry unburned, LMB = Lac Ekomiak mesic burned, LMC = Lac Ekomiak mesic unburned, KB = Kuujjuarapik burned, KC = Kuujjuarapik unburned site

	LDB	LDC	LMB	LMC	KB	KC
Lycosidae, inds.	59	16	45	32	104	28
Linyphiidae, inds.	44	35	34	22	110	172
Gnaphosidae, inds.	6	8	6	3	11	3
Others, inds.	6	5	6	14	3	0
Total, inds.	115	64	91	71	228	203
Species richness	24	13	15	18	31	20
Shannon H	3.98	3.27	3.50	3.52	3.62	3.31
Evenness E	0.87	0.88	0.90	0.84	0.73	0.77

period was 24 July-20 August 1990; traps were not changed during the period.

2. At Kuujjuarapik, a small area (about 50 x 15m) of *Picea glauca* (Moench) Voss forest was burned in July 1989. The site is in an isolated, small-sized woodland near forestline. Ground layer was dominated by *Pleurozium* and *Empetrum*. The field and ground layer vegetation was destroyed but the intensity of fire had been less than at Lac Ekomiak. The trapping period was 14 July-19 August 1990. The traps were changed once (1 August).

Ten traps were placed at each site (dry burned, dry unburned, mesic burned and mesic unburned) at Lac Ekomiak and five traps at each site (burned and unburned) at Kuujjuarapik. Pitfall traps were plastic cups (diameter 6.5cm, height 7cm) with ethylene glycol (2.5cm) as a preservation liquid. They were provided with covers (12 x 12cm) against rainfall and litter, and there was 2-3cm space between the cover and the ground. Traps were placed in a line at each site, average distance between the traps being 2m.

The indices used are Shannon-Wiener index of diversity:

$$H = -\sum_{i=1}^{s}(p_i)(log_2\, p_i)$$

and evenness: E = H/logS (S = number of species, p_i = proportion of total sample belonging to the ith species). The spider material is deposited in the Zoological Museum, University of Turku, Finland.

	Species	n	%BS	site 'preference'
DRY SITE	*Alopecosa aculeata*	6	100.0	only at burned
	Pardosa hyperborea	15	93.3	strongly to burned
	Diplocentria bidentata	10	90.0	strongly to burned
	Trochosa terricola	16	75.0	to burned
	Pardosa spp.*	31	58.1	equally occurring
	Gnaphosa spp.	8	50.0	equally occurring
	Agyneta olivacea	7	42.9	equally occurring
	*Hilaira herniosa***	13	15.4	to control
MESIC SITE	*Pardosa hyperborea*	10	90.0	strongly to burned
	Diplocentria bidentata	6	83.3	to burned
	Gnaphosa microps	9	66.7	slightly to burned
	Pardosa spp.*	42	66.7	slightly to burned
	Ozyptila gertschi	13	46.2	equally occurring
	*Hilaira herniosa***	7	14.3	to control
	Pardosa moesta	15	0.0	only at control

TABLE 2. Common spiders (≥ 6) trapped at burned and unburned (control) sites, at Lac Ekomiak, Québec. n = total number of individuals trapped, both sites combined; %BS = percentage individuals caught at burned site . * = *Pardosa uintana*, *P. mackenziana* and *P. xerampelina*; ** = adults of *H. herniosa* and juvenile *Hilaira* specimens.

Species	n	% BS	'preference'
Pardosa hyperborea	16	100.0	only at burned site
Pocadicnemis americana	6	100.0	only at burned site
Arctosa alpigena	9	77.8	to burned site
Pardosa uintana	100	74.0	to burned site
Gnaphosa muscorum	10	70.0	slightly to burned site
Sisis rotundus	10	60.0	equally occurring
Sisicottus montanus	22	59.1	equally occurring
Agyneta allosubtilis	19	15.8	to control site
Latithorax obtusus	13	15.4	to control site
Lepthyphantes alpinus	7	14.3	to control site
*Hilaira herniosa**	66	13.6	to control site
Lepthyphantes complicatus	19	5.3	strongly to control site

TABLE 3. Common spiders (≥ 6) trapped at burned and unburned (control) sites at Kuujjuarapik, Québec. n = total no. of individuals trapped, both sites combined; % BS =percentage individuals caught at burned site; * = adults of *H. herniosa* and juvenile *Hilaira* specimens.

RESULTS

A total of 772 spiders was collected from 6 study sites (3 burned, 3 unburned) in northern Québec during July-August, 1990. Individuals of two families, Linyphiidae and Lycosidae, clearly dominated all collections; individuals of Gnaphosidae ranked third among trap captures (Table 1).

Both at Lac Ekomiak and at Kuujjuarapik, trap captures were higher at burned sites than at unburned sites. This was mainly due to the great numbers of Lycosidae caught at open burned sites. The figures for the two most abundant families were (Lac Ekomiak and Kuujjuarapik combined): Lycosidae 208 at burned and 76 at unburned sites, Linyphiidae 188 and 229 respectively. In general, at the burned sites, the diversity (H) was higher or equal compared to the unburned controls (Table 1).

Altogether 56 species were caught, 37 species were trapped at Lac Ekomiak and 34 at Kuujjuarapik. Number of species from burned sites was 47; from unburned sites 37; 28 species were common to both burned and unburned sites. Linyphiidae (Erigoninae and Linyphiinae), Lycosidae, and Gnaphosidae were numerically dominant in species number, with 31 (24 and 7), 9 and 6 respectively.

Species that actively colonized the burned sites included, among the lycosids, *Pardosa hyperborea* (Thorell) in both study areas and *Alopecosa aculeata* (Clerck) at Lac Ekomiak (Tables 2, 3). The species group of *Pardosa uintana* Gertsch, *P. mackenziana* (Keyserling) and *P. xerampelina* (Keyserling), including many juveniles, as well as *Arctosa alpigena* (Doleschal) at Kuujjuarapik, and *Trochosa terricola* Thorell at Lac Ekomiak, also were more abundant at burned than unburned sites.

The gnaphosids caught, *Gnaphosa microps* Holm and *G. muscorum* (L.Koch), were slightly more abundant at burned than unburned sites. Of the linyphiids (Erigoninae), *Diplocentria bidentata* (Emerton) and *Pocadicnemis americana* Millidge apparently 'preferred' burnt areas (Tables 2, 3).

Many species were represented by less than 6 individuals captured, and consequently not included in the Tables 2, 3. Several were found only at burned sites. This group included: *Gnaphosa parvula* Banks, *Zelotes fratris* Chamberlin, *Pardosa furcifera* (Thorell), *Neon nelli* Peckham and Peckham, *Sisicus apertus* (Holm), *Ceraticelus atriceps* (O.P.-Cambridge), *Horcotes quadricristatus* (Emerton), *Sciastes truncatus* (Emerton), *Tunagyna debilis* (Banks), *Walckenaeria atrotibialis* O.P.-Cambridge, *W. castanea* (Emerton), *W. directa* (O.P.-Cambridge) and *W. tricornis* (Emerton).

Several species seemed to lack habitat specificity and were equally found in marked numbers at both burned and unburned sites. Such species included the linyphiids, *Sisis rotundus*

(Emerton), *Sisicottus montanus* (Emerton) and *Agyneta olivacea* (Emerton); and the thomisid *Ozyptila gertschi* Kurata. These generalist species must be regarded as colonizer species because of their common occurrence at burned sites. Although only in a few cases (*Pardosa hyperborea* and *P. uintana*) 'preferences' to burned areas were statistically significant, about 30 of the 47 species caught at burned sites can be regarded as potential colonizers in the subarctic postfire forests investigated.

Species that clearly avoided burned sites were the linyphiids *Lepthyphantes complicatus* (Emerton), *L. alpinus* (Emerton), *Hilaira herniosa* (Thorell), *Latithorax obtusus* (Emerton), and *Agyneta allosubtilis* Loksa. Of the lycosids, *Pardosa moesta* Banks was found only at the unburned mesic forest at Lac Ekomiak.

DISCUSSION

The burned areas at Lac Ekomiak and at Kuujjuarapik greatly differed both in the intensity of fire and in the size of area burned. At Kuujjuarapik, spiders easily colonized the burned site from surrounding nearby natural areas. By contrast, at Lac Ekomiak, species colonizing the burned sites came from long distances (i.e., several hundred metres), especially at the dry burned site. The possible survival of spiders in the burnt area during the fire is open to discussion (cf. McKay, 1979: 246); however, at the dry burned site its seems to be improbable due to the intensity of the fire.

The spider community trapped at burned sites one year after fire was rich; the diversity (H) was not lower than at unburned sites. Similar results were found in subarctic Finland during the first postfire summer (Koponen, 1988). This contrasts with some earlier studies (Schaefer, 1980; Metz and Dindal, 1980). However, also Schaefer (1980) observed high diversity values already two years after fire in pine forests of Germany.

Some of the species that colonized burned sites in northern Québec are considered pioneer species in other northern areas, e.g. *Diplocentria bidentata* in burned areas of northern Finland (Koponen, 1988).

ACKNOWLEDGEMENTS

I thank Louise Filion and the staff of Centre d'études nordiques for working facilities and generous help at Kuujjuarapik and Québec City. Luc Sirois provided help at Lac Ekomiak, and Heli Hurme participated in the field work.

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